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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/733,768	12/12/2003	Rainer Mielke	2560-0417	8742

7590 07/27/2006

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EXAMINER	
SMITH, NICHOLAS A	

ART UNIT	PAPER NUMBER
1742	

DATE MAILED: 07/27/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/733,768	MIELKE, RAINER	
	Examiner	Art Unit	
	Nicholas A. Smith	1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-15* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2 and 4-15* is/are rejected.

7)☒ Claim(s) *3* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *10/28/04, 12/13/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Status of Claims

Claims 1-15 remain for examination.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-2 and 4-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Derehag et al (WO 02/072303) in view of Kiyomiya (JP 2002-292524) and Metzinger et al (US 6,542,843).

In regards to claim 1, Derehag et al. teaches a method of material removal including a linear oscillation of at least one of an electrode and a component to be machined is performed relative to the other, a circular oscillation of at least one of the electrode and the component to be machined is performed relative to the other, and a linear feed and a circular feed of at least one of the electrode and the component to be machined relative to the other are performed simultaneously, as well as simultaneously to at least one of the circular oscillation and the linear oscillation to form a complex shape, such as a blisk (p. 9, lines 8-18).

However, Derehag et al. does not specifically teach the method as electrochemical machining (ECM) in the presence of an electrolyte, only electrical discharge machining (EDM).

Kiyomiya teaches (English abstract) utilizing a single apparatus for either ECM or EDM.

Metzinger et al teach a method of producing matched surfaces on rotor units with integral blades (claim 1) using either ECM or EDM (claim 7).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have utilized the feed/oscillation method of Derehag et al with an ECM method because Metzinger et al. teach that ECM and EDM were art recognized equivalents for the shaping of turbine blisks. Kiyomiya teach that one of ordinary skill in the art was aware that both EDM and ECM could have utilized the same apparatus for performing the shaping. Thus, one of ordinary skill in the art would have had a reasonable expectation of successfully applying the feed/oscillation method of Derehag et al. to an ECM method as disclosed by Metzinger et al.

In regards to claim 2, Derehag et al. teaches linear feed and oscillation by the electrode and circular feed and oscillation by the workpiece (p. 9, lines 8-18).

In regards to claim 4, Derehag et al. teaches removal of material on various portions of the component to be machined synchronously (p.3, lines 34-37).

In regards to claim 5, Derehag et al. teaches removal of material on various portions of the component to be machined separately (p. 3, lines 34-37).

In regards to claim 6, Derehag et al. teaches linear feed and oscillation by the workpiece and circular feed and oscillation by the electrode (p. 9, lines 8-18).

Claims 7-9, 12-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Derehag et al. in view of Tchugunov (US Patent 6,835,299).

ordinary skill in the art to substitute Burns et al.'s linear drive associated with the workpiece holder in Derehag et al. in view of Tchugunov's linear drive as a linear drive on either the workpiece holder or the electrode holder would impart the same relative motion necessary to machine a blisk. In regards to having separate drives for each of the feeding and oscillating movements, Derehag et al. in view of Tchugunov is applied for the same reasons as above in claim 7.

In regards to claim 11, Derehag et al. in view of Tchugunov is applied for the same reasons as above in claim 7.

Allowable Subject Matter

Claim 3 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 3 is allowable for the following reason:

- Claim 3 is a method of electrochemical machining to form the negative of complex shapes, such as blisks, made by a sample complex shape (e.g., blisk) serving as an electrode. Derehag et al. teaches the machining steps of linear oscillating and feeding movements as well as the steps of circular oscillating and feeding movements, performed simultaneously. Derehag et al. also teaches the manufacturing of the electrode tool (p. 10, lines 1-3), implied to be used to made for making multiple blisks as in the above method. However, Derehag et al. does not suggest machining the electrode tool (i.e, the negative of the complex shape) by the above

In regards to claim 12, Derehag et al. does not specifically mention that either the electrode holder or the workpiece holder is transversable in at least one of the X and the Y directions.

Tchugunov teaches an electrode holder capable of transversable movement in X and Y directions (col. 4, lines 35-43). It would have been obvious to one of ordinary skill in the art at the time of invention to use Tchugunov's transversable electrode holder in Derehag et al.'s apparatus as it is capable of adjusting lateral position for machining (Tchugunov, col. 4, lines 38-43).

In regards to claims 13 and 14, Derehag et al. teaches an apparatus where circular movements are performed around an axis of linear oscillation movements (p. 9, lines 8-18).

In regards to claim 15, Derehag et al. in view of Tchugunov is applied for the same reasons as above in claim 7.

Claims 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Derehag et al. in view of Tchugunov and further in view of Burns et al. (US Patent 4,851,090) as in applicant's information disclosure statement as submitted on 10/28/04.

In regards to claim 10, Derehag et al. in view of Tchugunov teaches a linear drive but implies it is associated with the electrode holder.

However, Derehag et al. in view of Tchugunov does not specifically teach that a linear drive is associated with the workpiece holder.

Burns et al. teaches an apparatus for electrochemical machining of blisks using a workpiece holder with a linear drive (Figure 2). It would have been obvious to one of

Derehag et al. teaches an apparatus with a workpiece holder and an electrode holder with a linear drive capable of oscillating and feeding movements, a circular drive capable of reciprocating and feeding movements in which the apparatus is capable of simultaneous linear and circular feeding movements.

However, Derehag et al. does not specifically teach having a separate drive for each of the linear oscillating and feeding movements as well as having a separate drive for each of the circular oscillating and feeding movements, totaling four drives.

Tchugunov teaches an electrochemical machining apparatus that includes both a drive for linear feeding movement and a drive for linear oscillating movement (col. 3, lines 36-45). A linear feeding movement and a linear oscillating movement can be performed with either two separate drives (Tchugunov) or one drive (Derehag et al.). It would have been obvious to one of ordinary skill in the art at the time of invention to use either two separate drives of Tchugunov or one drive of Derehag et al. as they both facilitate machining of different shapes (Tchugunov, col. 3, lines 46-48 and Derehag et al., p. 9, lines 8-18). The same reasons as above applies to substituting a separate drive for circular feeding movement and for circular oscillating movement instead of only one drive capable of both movements.

In regards to claim 8, Derehag et al. teaches a circular drive associated with the workpiece holder (p. 11, claim 2) and linear drive(s) associated with the electrode (p. 9, lines 13-18).

In regards to claim 9, Derehag et al. in view of Tchugunov is applied for the same reasons as above in claim 7.

specific method of linear oscillating and feeding movements as well as the steps of circular oscillating and feeding movements, performed simultaneously. Therefore, claim 3 would be patentable if properly rewritten as stated above.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nicholas A. Smith whose telephone number is (571)-272-8760. The examiner can normally be reached on 8:30 AM to 5:00 PM, Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy King can be reached on (571)-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Harry D. Wilkins, III
Primary Examiner
Art Unit 1742

NAS

FORM PTO-1449 (modified)
To: U.S. Department of Commerce
(PW FORM PAT-1449)
Patent and Trademark Office

Information Disclosure Statement by Applicant

Attorney Docket No.:	2560-0417
Applicant:	MIELKE, Rainer
Appln. S.N.:	10/733,768
Filing Date:	December 12, 2003
Examiner:	Unknown
Group Art Unit:	1742

Date: October 28, 2004 | **Page 1 of 1**

U.S. PATENT DOCUMENTS

Examiner's Initials		Document Number	Date MM/YYYY	Name (Family Name of First Inventor)	Class	Sub Class	Filing Date (if appropriate)
NS	AR	4,213,834	07/1980	Semashko et al.			
NS	BR	4,257,865	03/1981	Semashko et al.			
NS	CR	4,323,749	04/1982	Mazond et al.			
NS	DR	4,491,712	01/1985	Ito			
NS	ER	4,628,173	12/1986	Ito			
NS	FR	4,851,090	07/1989	Burns et al.			
NS	GR	4,948,488	08/1990	Tsymbal et al.			
NS	HR	5,038,012	08/1991	Walter			
NS	IR	4,999,093	03/1991	Moracz			
	JR						
	KR						
	LR						
	MR						
	NR						

FOREIGN PATENT DOCUMENTS

		Document Number	Date MM/YYYY	Country	Inventor Name	English Abstract Enclosed	English Abstract No	Translation Readily Available Enclosed	Translation Readily Available No
NS	OR	2903873	08/1979	Germany	Semaschko et al.	☐	☒	☒	☐
NS	PR	3036134	04/1981	Germany	Mazond et al.	☐	☒	☒	☐
NS	QR	3135918	06/1982	Germany	Ito	☐	☒	☒	☐
NS	RR	0292213	11/1988	Europe	Burns et al.	☐	☒	☒	☐
NS	SR	3922913	01/1991	Germany	Cymbal et al.	☐	☒	☒	☐
NS	TR	3829363	08/1991	Germany	Walter	☐	☒	☒	☐
	UR					☐	☐	☐	☐
	VR					☐	☐	☐	☐
	WR					☐	☐	☐	☐
	XR					☐	☐	☐	☐

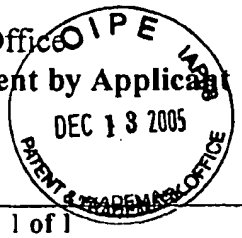
OTHER (Including in this order Author, Title, Periodical Name, Pertinent Pages, etc.)

NS	YR	German Search Report dated December 17, 2002	☐	☐	☐	☐
	ZR		☐	☐	☐	☐
	AAR		☐	☐	☐	☐

Examiner: /Nicholas Smith/ **Date Considered:** 07/19/2006

***EXAMINER:** Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

FORM PTO-1449 (modified)
To: U.S. Patent and Trademark Office
Information Disclosure Statement by Applicant



Attorney Docket No.:	2560-0417
Applicant:	MIELKE, Rainer
Appln. S.N.:	10/733,768
Filing Date:	December 12, 2003
Examiner:	Unknown
Group Art Unit:	1742

Date: December 13, 2005 | **Page 1 of 1**

U.S. PATENT/PATENT APPLICATION DOCUMENTS

Examiner's Initials		Document Number	Date MM/YYYY	Name (Family Name of First Inventor)	Class	Sub Class	Filing Date (if appropriate)
	AR						
	BR						
	CR						
	DR						
	ER						
	FR						
	GR						
	HR						
	IR						
	JR						
	KR						
	LR						
	MR						
	NR						

FOREIGN PATENT DOCUMENTS

		Document Number	Date MM/YY YY	Country	Inventor Name	English Abstract: Enclosed/ Cited Above	English Abstract: NO	Translation Readily Available? Enclosed/ Cited Above	Translation Readily Available? NO
NS	OR	0 292 213 A	11/1998	Europe	Bruns	☐	☐	☐	☐
NS	PR	1 249 294 A2	10/2002	Europe	Ishiwata	☐	☐	☐	☐
	QR					☐	☐	☐	☐
	RR					☐	☐	☐	☐
	SR					☐	☐	☐	☐
	TR					☐	☐	☐	☐
	UR					☐	☐	☐	☐
	VR					☐	☐	☐	☐
	WR					☐	☐	☐	☐
	XR					☐	☐	☐	☐

OTHER (Including in this order Author, Title, Periodical Name, Pertinent Pages, etc.)

	YR	☐	☐	☐	☐
	ZR	☐	☐	☐	☐
	AAR	☐	☐	☐	☐
	BBR	☐	☐	☐	☐
	CCR	☐	☐	☐	☐

Examiner: /Nicholas Smith/ **Date Considered:** 07/19/2006

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

Notice of References Cited	Application/Control No. 10/733,768	Applicant(s)/Patent Under Reexamination MIELKE, RAINER	
	Examiner Nicholas A. Smith	Art Unit 1742	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,835,299 B1	12-2004	Tchugunov, Boris	205/654
*	B	US-6,542,843 B1	04-2003	Metzinger et al.	702/113
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	WO 2072303 A1	09-2002	World Intellect	DEREHAG et al.	B23H 9/10
	O	JP 2002292524 A	10-2002	Japan	KIYOMIYA, KOICHI	B23H 5/02
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 September 2002 (19.09.2002)

PCT

(10) International Publication Number
WO 02/072303 A1

(51) International Patent Classification[7]: B23H 9/10

(21) International Application Number: PCT/SE02/00086

(22) International Filing Date: 18 January 2002 (18.01.2002)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
0100880-4 14 March 2001 (14.03.2001) SE

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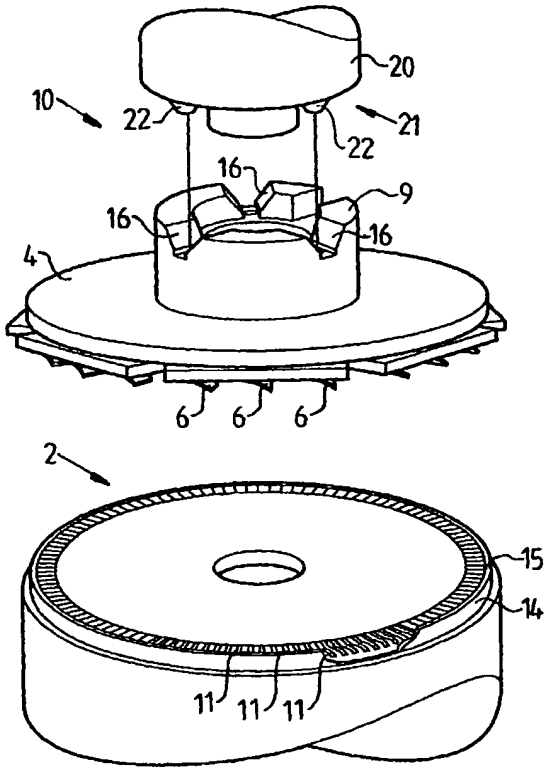
(74) Agent: FRÖHLING, Werner, Otto; Volvo Technological Development Corporation, Patent Department, CTP, 06820, Sven Hultins Gata 9C, S-412 88 Göteborg (SE).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: A METHOD AND A DEVICE FOR MANUFACTURING A STATOR COMPONENT OR ROTOR COMPONENT



(57) Abstract: The invention relates to a method for manufacturing a disk-shaped or annular stator component or rotor component with a plurality of blades arranged one after another in a path extending around said component and a cover (15) arranged outside the blades in the radial direction and in contact therewith. According to the method, at least a portion (11) of a first set of channels (12) is electro discharge machined simultaneously out of a disk-shaped or annular workpiece (2) intended for forming the component at a distance from the edge (14) of the workpiece in the radial direction, which channels (12) are intended to delimit said blades in the circumferential direction of the workpiece.

WO 02/072303 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A method and a device for manufacturing a stator component or rotor component

FIELD OF THE INVENTION

The present invention relates to a method for manufacturing a disk-shaped or annular stator component or rotor component with a plurality of blades arranged one after another in a path extending around said component for guiding a gas flow. In other words, such a component can be used in both static applications (stators) and dynamic applications (rotors). This component is commonly referred to as a "blisk" (bladed disk) or a "bling" (bladed ring). The invention also relates to a device for manufacturing said stator component or rotor component.

In the following description, the stator component or rotor component is intended to be arranged in a turbopump in a space application. Turbopump means a unit which comprises at least a turbine and a pump part driven by the latter. The invention is not to be regarded as being limited to this application but can also be used in a gas turbine. Other areas of application are also possible, such as in engines for vehicles, aircraft, power plant equipment for vessels and power stations for electricity production.

The stator component or rotor component is often designed with an annular cover outside the blades in the radial direction and in contact with these. This cover outside the blades is arranged for the purpose of counteracting leakage from a pressure side to a suction side of the blades concerned. Such leakage is associated with efficiency losses.

PRIOR ART

There are a number of different known ways of manufacturing such a stator component or rotor component. According to a previously known

manufacturing technique, each of the blades is manufactured individually. The blades are subsequently secured with a mutual spacing in a groove on the periphery of a circular disk so that they project in the radial direction from the latter. Each of the blades is often manufactured with a cover part in such a way that an essentially continuous cover is formed after the blades have been mounted on the circular disk.

It is moreover known to use electro discharge machining (EDM) in the manufacture of said stator component or rotor component. In this case, each blade is produced separately by electro discharge machining a disk-shaped or annular workpiece intended to form the component. Four electro discharge machining stages (and four different electro discharge machining electrodes) are required for manufacturing each of said blades. During EDM, half the blade is machined from a first side of the workpiece via a first and a second electro discharge machining operation on the pressure side and, respectively, the suction side of the blade. When all the blades have been machined from the first side of the workpiece, it is turned, and the remaining part of each of the blades is machined from the second side of the workpiece via a third and a fourth EDM operation.

DISCLOSURE OF THE INVENTION

One object of the invention is to provide a method for manufacturing a disk-shaped or annular stator component or rotor component which is time-efficient and cost-effective. The invention also aims to achieve a manufacturing method which creates possibilities for a component with great strength and improved efficiency.

This object is achieved by virtue of the fact that at least a portion of each of a plurality of channels in a first set of channels is electro discharge machined simultaneously out of a disk-shaped or annular

workpiece intended for forming the component, which channels are intended to delimit said blades in the circumferential direction of the workpiece.

On the whole, the manufacturing method is non-sensitive to the material to be machined. The stator component or rotor component is manufactured from a single piece, which creates possibilities for great strength, especially in combination with a material which tolerates great temperature transients, such as what is known as a superalloy. In order for it to be possible to machine a plurality of channels simultaneously, a plurality of EDM electrodes are in engagement with the workpiece simultaneously.

In such electro discharge machining, which is known per se, material is removed from the surface of the workpiece under the action of a power density which arises when short electrical discharges take place between an EDM electrode and the workpiece. Here, the EDM electrode has the shape of a negative replica of the intended shape of the channel.

According to a preferred embodiment of the invention, after EDM of said portion of the first set of channels, the workpiece is rotated through a distance in its circumferential direction, and then at least a portion of each of a plurality of channels in a second set of channels is electro discharge machined. The EDM electrodes intended for the electro discharge machining are therefore arranged at a spacing in the circumferential direction of the workpiece which is greater than the intended spacing between the channels. In other words, machining of a plurality of channels takes place simultaneously, after which the EDM means is indexed and a new set of channels can be machined out of the workpiece.

According to a development, the workpiece is turned after all the channels have been electro discharge machined from a first side of the same, and the remaining portion of the channels is then electro discharge machined in the same way from its second side. In this way, relatively complex blade shapes can also be produced.

According to another preferred embodiment, said channels are electro discharge machined at a spacing from the edge of the workpiece in the radial direction, so that a cover is formed outside the blades in the radial direction and in contact therewith. In other words, the cover is formed by the material of the workpiece remaining outside the blades in the radial direction. In this way, a continuous cover is formed, which creates possibilities for a component with great efficiency.

According to another preferred embodiment of the invention, in a first operation, a plurality of EDM electrodes are machined, with a mutual spacing along a curved path, from at least one basic element arranged on a means intended for the EDM, and, in a second operation, the channels are electro discharge machined from the workpiece by means of said EDM electrodes. The machining in the first operation preferably comprises milling. The method for manufacturing the component therefore comprises two stages, namely firstly manufacturing the tool itself which is to be used for EDM and subsequently electro discharge machining of the workpiece by means of the EDM tool manufactured in this way.

According to a development of the preceding embodiment, the attachment of the EDM means has such a shape that it can be used on the one hand in a machine tool for said manufacture of the EDM electrodes and on the other hand in an EDM machine for said manufacture of the

channels by EDM. In this way, the method can be implemented by means of conventional machines for milling and EDM.

According to another development of the preceding embodiment, a plurality of said basic elements are arranged on the EDM means in a path extending around said means before machining, and at least one of said EDM electrodes is machined from each of them in the first operation. By using a plurality of such basic elements, only one of these has to be replaced if one of the EDM electrodes should for any reason become defective during milling thereof or during movement and mounting of the EDM means in the EDM machine.

Another object of the invention is to produce a device which creates possibilities for time-efficient and cost-effective manufacture of a disk-shaped or annular stator component or rotor component. This object is achieved by a device according to claim 12. Further advantageous embodiments of the invention emerge from the following claims and the description.

BRIEF DESCRIPTION OF FIGURES

The invention will be described in greater detail below with reference to the embodiments shown in the accompanying drawings, in which

Figure 1 illustrates a perspective view of an EDM means arranged in a milling machine for milling EDM electrodes;

Figure 2 illustrates a partly cut-away perspective view of the workpiece arranged in an EDM machine, and

Figure 3 illustrates a partly cut-away perspective view of the disk-shaped or annular stator component or rotor component.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

According to an embodiment, the method for manufacturing a stator component or rotor component 1 comprises two stages, namely firstly manufacturing the tool itself which is to be used in subsequent EDM and then electro discharge machining a workpiece 2 by means of the EDM tool manufactured in this way. Here, the manufacture of the EDM tool is carried out by milling.

In electro discharge machining, material is removed from the surface of the workpiece 2 under the action of a power density which arises when short electrical discharges take place between an EDM electrode 6 and the workpiece 2, see Figure 2. The workpiece 2 and the EDM tool are submerged in a dielectric liquid, and voltage is applied, material then being burned away from the workpiece. Here, the EDM tool forms a cathode, and the workpiece forms an anode. Furthermore, the EDM electrode has the shape of a negative replica of the intended shape of the cutout.

Fig. 1 shows a plurality of basic elements 3 arranged in an at least essentially circular path on a top side of a holder element which comprises a disk 4. The basic elements 3 are secured on the disk 4 by screw joints 18. Each of the basic elements 3 has three upwardly projecting portions 5 which are intended to form EDM electrodes 6, see Figure 2. The disk 4 is arranged in a milling machine 7 known per se, and each of the projecting portions 5 is intended to be machined using a milling tool 8. The upwardly projecting portions 5 are arranged at a sufficiently great spacing from one another for it to be possible to reach with the milling tool 8 for the purpose of giving the projecting portions 5 the desired shape.

In a first operation of the method, the EDM electrodes 6 are machined from the basic elements 3 by milling, with a mutual spacing along a circular path. The holder

element comprising the disk 4 and a first machine attachment part 9 located under the disk and connected rigidly thereto form an EDM means intended for an EDM operation following the milling operation. The first machine attachment part 9 is designed so as to be capable of being used both in a milling machine and in an EDM machine. The first machine attachment part 9 is designed so as to fit together with a second machine attachment part 17 of the milling machine. To this end, the first and second machine attachment parts 9, 17 are designed with male and female parts for engagement with one another. The first machine attachment part 9 has three recesses 16 arranged with even spacing in the circumferential direction of the disk 4. The recesses 16 are open in a direction opposite to that side of the disk 4 on which the basic pieces 3 are arranged. The second machine attachment part 17 has three projecting portions 19 for fitting into the recesses 16. In this way, highly accurate centering of the disk 4 is brought about. The projecting portions 19 have the shape of a truncated cone. The EDM means is referred to below using reference number 4. Figure 1 illustrates the basic elements 3 before milling has been started.

In Figure 2, the EDM means 4 is arranged at the top in an EDM machine 10. In relation to Figure 1, the EDM means 4 has been turned through 180° so that the EDM electrodes 6 project downward. According to the embodiment illustrated in Figures 1 and 2, the EDM means 4 has seven basic elements 3 which each have three EDM electrodes 6. In total, there are 21 EDM electrodes. After a reciprocating movement of the EDM means during EDM, 21 cutouts 11 are therefore formed in a workpiece 2. Figure 2 illustrates that the cutouts 11 do not extend through the entire thickness of the disk. The cutouts 11 are intended to form channels 12, see Figure 3. Two adjacent such channels 12 in turn delimit a blade 13. The cutouts 11 extend roughly halfway through the disk.

The EDM machine has a third machine attachment part 20, see Figure 2. The lower part 21 of this is designed for engagement with the recesses 16 and is preferably identical with the second machine attachment part 17 of the milling machine 7 for the purpose of bringing about good centering of the EDM means 4. The third machine attachment part 20 therefore has three cone-shaped projecting portions 22 for engagement with the recesses 16.

In a first EDM stage, a portion (said 21 cutouts 11) of each of a plurality of channels 12 in a first set of channels is therefore machined out of the workpiece 2. The EDM means 4 is then rotated through a number of degrees and then, in a second EDM stage, 21 further cutouts are machined. The EDM operation continues with further rotation of the EDM means followed by further EDM stages until the spacing between two adjacent cutouts 11 in the circumferential direction of the workpiece 2 is essentially the same around the entire workpiece and corresponds to the desired blade thickness.

As can be seen from Figure 2, material is machined away from the workpiece 2 at a spacing from its edge 14 in the radial direction. A portion is therefore retained outside the channels 12. This portion is intended to form a cover 15 for the blades 13 formed subsequently. Figure 2 illustrates the workpiece when the EDM operation from a first flat side thereof has been performed.

The EDM operation continues after the workpiece 2 has been turned, and electro discharge machining is then carried out in the same way from its second flat side. The cutouts from the second side of the workpiece are electro discharge machined out of the workpiece 2 so that they are connected to the cutouts 11 from the

first side, and in this way said channels 12 are formed. The channels 12 will thus extend through the workpiece in the axial direction at a spacing from its edge 14 in the radial direction. The blades 13 are defined between the channels 12 in the circumferential direction of the workpiece.

Each of the EDM electrodes 6 has a shape which corresponds essentially to the shape of the desired channels 12. In order to bring about the desired domed shape of the blades 13, the EDM means 4 is made to perform both a reciprocating movement and a rotary movement in each EDM stage. To be precise, each EDM electrode 6 is guided into the workpiece 2 along a predetermined path. The EDM means 6 is made to perform an oscillating movement when the EDM electrodes have reached their final position in order to produce the desired structure on the channel walls.

Two opposite surfaces of each of the channels in the circumferential direction of the disk are electro discharge machined simultaneously and, to be precise, by the same EDM electrode 6. In other words, the convex surface of one blade and the concave surface of an adjacent blade are electro discharge machined simultaneously.

The machine attachment 9 of the EDM means 4 is designed so that it is possible to use the EDM means 4 both clamped on, in a static position, in a milling machine for machining the EDM electrodes 6 and for rotation in a EDM machine for the purpose of machining the workpiece 2.

The invention is not to be regarded as being limited to the illustrative embodiments described above, but a number of further variants and modifications are conceivable within the scope of the following patent claims.

For example, methods other than milling are possible for manufacturing the EDM tool, for example grinding and wire EDM.

PATENT CLAIMS

1. A method for manufacturing a disk-shaped or annular stator component or rotor component (1) with a plurality of blades (13) arranged one after another in a path extending around said component for guiding a gas flow, characterized in that at least a portion (11) of each of a plurality of channels (12) in a first set of channels is electro discharge machined simultaneously out of a disk-shaped or annular workpiece (2) intended for forming the component (1), which channels (12) are intended to delimit said blades (13) in the circumferential direction of the workpiece.

2. The method as claimed in claim 1, characterized in that, after electro discharge machining said portion (11) of the first set of channels (12), the workpiece (2) is rotated through a distance in its circumferential direction, and then at least a portion of each of a plurality of channels (12) in a second set of channels is electro discharge machined.

3. The method as claimed in claim 1 or 2, characterized in that the workpiece (2) is turned after all the channels have been electro discharge machined from a first side of the same, and in that the remaining portion of the channels (12) is then electro discharge machined in the same way from the second side of the workpiece.

4. The method as claimed in any one of the preceding claims, characterized in that an electrode (6) intended for electro discharge machining is, in the course of its trajectory in the workpiece (2), made to perform simultaneously on the one hand a translatory movement and on the other hand a rotary movement.

5. The method as claimed in any one of the preceding claims, characterized in that two opposite surfaces of each of the channels (12) in the circumferential

direction of the workpiece (2) are electro discharge machined simultaneously.

6. The method as claimed in claim 5, characterized in that the opposite surfaces of each of the channels (12) are electro discharge machined by the same EDM electrode (6).

7. The method as claimed in any one of the preceding claims, characterized in that said channels (12) are electro discharge machined at a spacing from the edge (14) of the workpiece in the radial direction, so that a cover (15) is formed outside the blades in the radial direction and in contact therewith.

8. The method as claimed in any one of the preceding claims, characterized in that, in a first operation, a plurality of EDM electrodes (6) are machined, with a mutual spacing along a curved path, from at least one basic element (3, 5) arranged on a means (4) intended for the electro discharge machining, and in that, in a second operation, the channels (12) are electro discharge machined from the workpiece (2) by means of said EDM electrodes (6).

9. The method as claimed in claim 8, characterized in that the attachment (7) of the EDM means (4) has such a shape that it can be used on the one hand in a machine tool for said manufacture of the EDM electrodes (6) and on the other hand in an EDM machine for said manufacture of the channels (12) by electro discharge machining.

10. The method as claimed in claim 8 or 9, characterized in that a plurality of said basic elements (3, 5) are arranged on the EDM means (4) in a curved path before machining, and in that at least one of said EDM electrodes is machined from each of them in the first operation.

11. The method as claimed in any one of claims 8-10, characterized in that said machining in the first operation comprises milling.

12. A device for manufacturing a disk-shaped or annular stator component or rotor component (1) with a plurality of blades (13) arranged one after another in a path extending around said component for guiding a gas flow, the device comprising an EDM means (4) adapted to be connected to a voltage and to be brought into contact with a workpiece (2) for removal of material from the latter for the purpose of forming one of said blades, characterized in that the EDM means (4) comprises a plurality of EDM electrodes (6) for said contact with the workpiece, which are arranged at a mutual spacing from one another in a curved path in such a way that at least a portion (11) of each of a plurality of channels (12) in a first set of channels can be electro discharge machined simultaneously out of the workpiece (2), which is disk-shaped or annular for forming the component (1), which channels (12) are intended to delimit said blades (13) in the circumferential direction of the workpiece.

13. The device as claimed in claim 12, characterized in that the EDM electrodes (6) are arranged one after another in a path which is at least partly circular.

14. The device as claimed in claim 12 or 13, characterized in that the EDM means (4) comprises a disk and a plurality of basic elements (3) secured on the disk, and in that each of the basic elements comprises a plurality of said EDM electrodes (6).

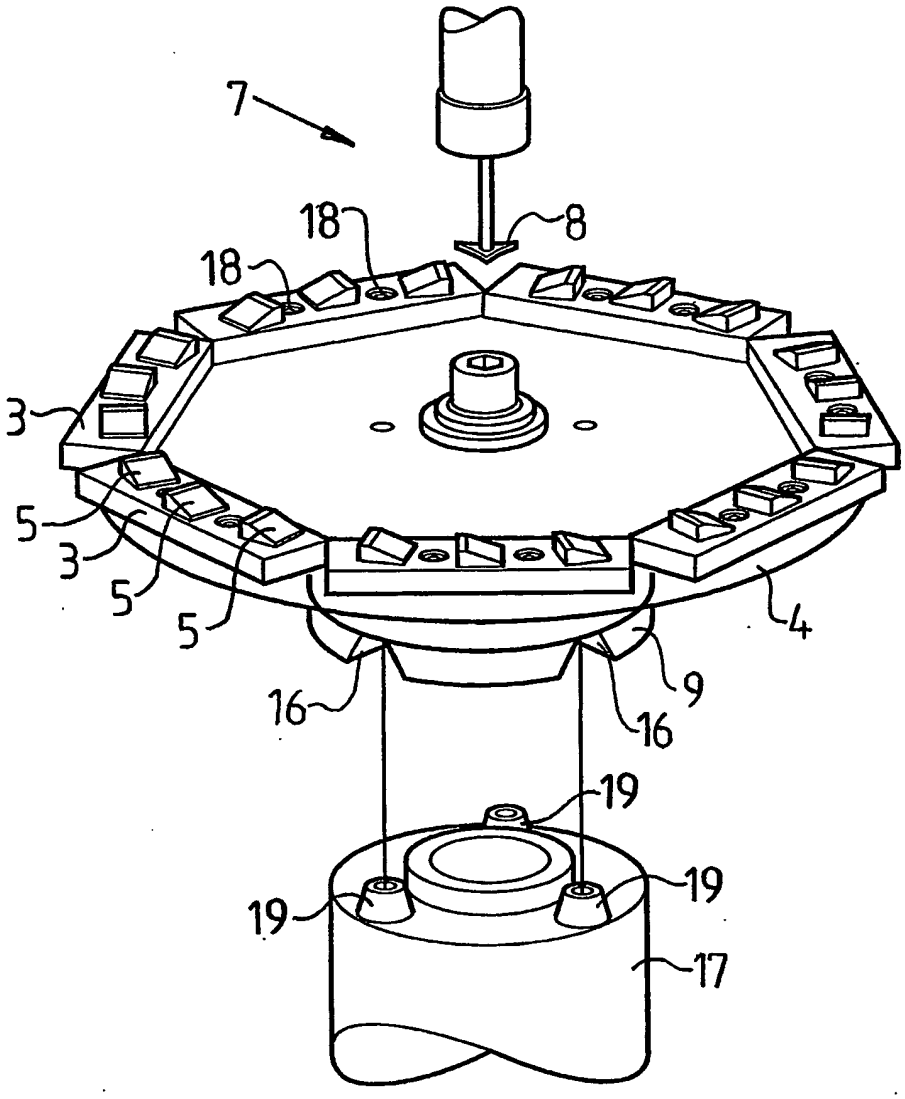


Fig.1

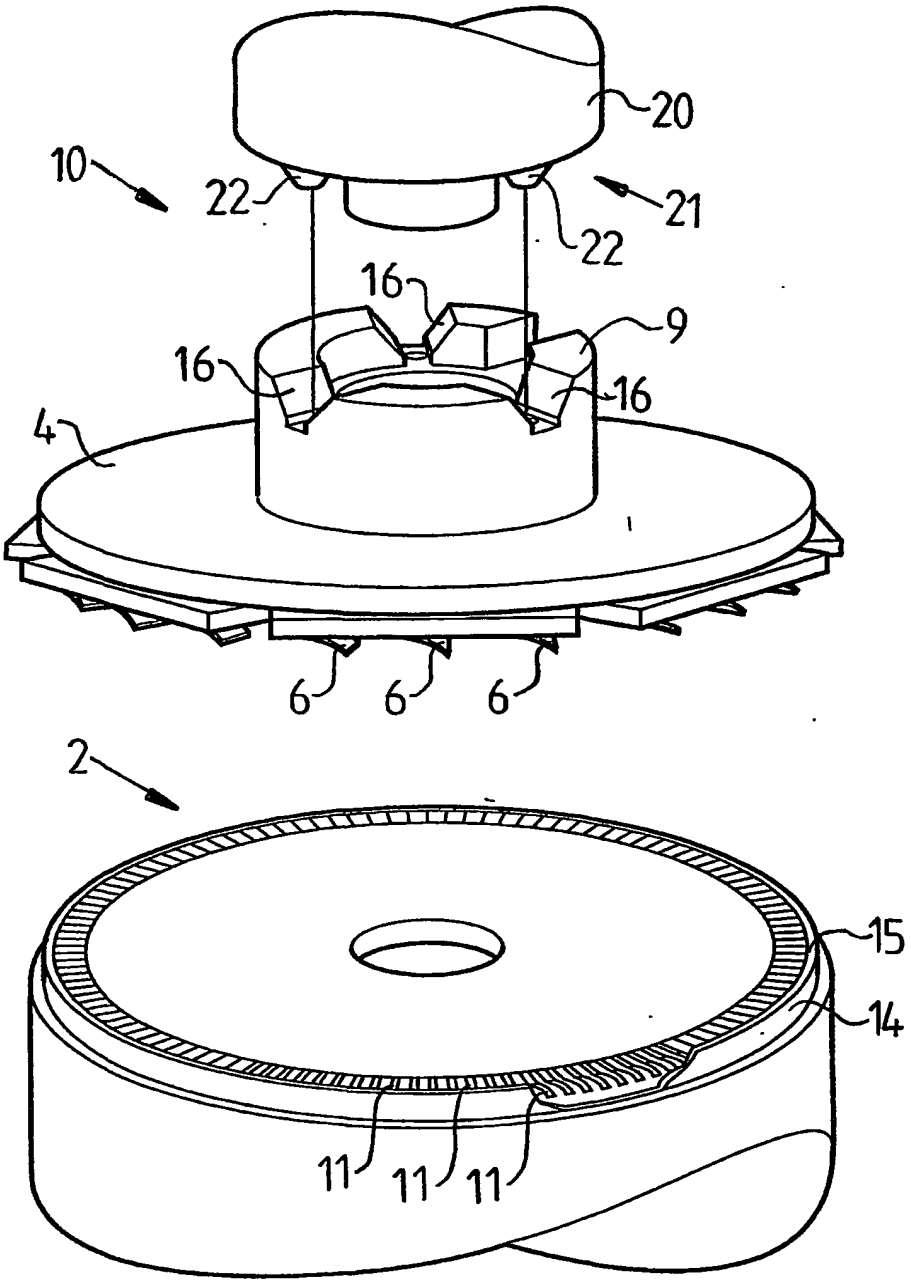


Fig.2

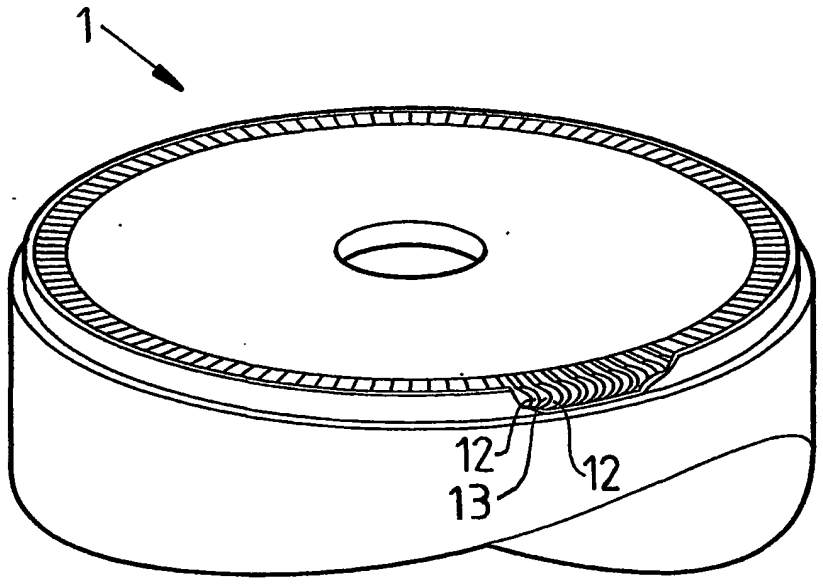


Fig.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00086

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B23H 9/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B23H, B23P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4888863 A (JIMMY A COX ET AL), 26 December 1989 (26.12.89) --	1,12
A	US 5014421 A (M.C. SWARDEN ET AL), 14 May 1991 (14.05.91) --	1,12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 May 2002	13 -05- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Magnus Westöö/MN Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.
PCT/SE 02/00086

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4888863 A	26/12/89	CA 1317444 A	11/05/93
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		IT 8941549 D	00/00/00
		JP 1274929 A	02/11/89
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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-292524

(43)Date of publication of application : 08.10.2002

(51)Int.Cl. B23H 5/02
C25F 3/16
C25F 7/00

(21)Application number : 2001-097135

(22)Date of filing : 29.03.2001

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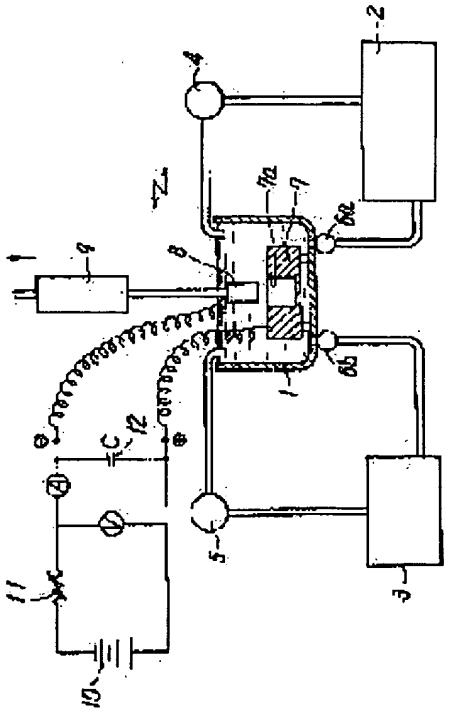
(54) ELECTROLYTE FINISHING METHOD FOR ELECTRIC DISCHARGING SURFACE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electrolyte finishing method for an electric discharging surface where an arrangement is miniaturized and a production cost is reduced by executing an electrical discharge machining and an electrochemical machining in the same device, and a high-precision positioning between an electrode tool and the electric discharging surface is enabled in polishing, and an improvement of workability is devised.

SOLUTION: In a vessel 1 filled with an electric discharge solution,a workpiece 7 is opposed at a specific interval to an electrode tool 8, which is movable toward Z axis which is orthogonal to both X, Y axis and is fixed for X, Y axis which are mutually orthogonal in a horizontal plane, and by making the workpiece 7 a positive electrode, and making the electrode tool 8 a negative electrode, a voltage is impressed between the electrodes. After having processed the workpiece 7 conform to the electrode form, the electric discharge solution in the vessel 1 is counterchanged with electrolytic solution, and a constant electrolytic current is passed between the electrode tool 8 and the workpiece 7, and an electrochemical machining surfaces 7a is abrasively finished.



LEGAL STATUS

[Date of request for examination] 29.03.2001

[Date of sending the examiner's decision of rejection] 06.01.2004

[Kind of final disposal of application other than the examiner's decision of rejection or application

converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号
特開2002－292524
（P2002－292524A）
(43)公開日　平成14年10月８日(2002.10.8)

(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード(参考)
Ｂ２３Ｈ　5/02		Ｂ２３Ｈ	5/02	３Ｃ０５９
Ｃ２５Ｆ　3/16		Ｃ２５Ｆ	3/16	Ｚ
7/00			7/00	Ｘ

審査請求　有　　請求項の数１　ＯＬ　（全　４　頁）

(21)出願番号　特願2001－97135(P2001－97135)

(22)出願日　平成13年３月29日(2001.3.29)

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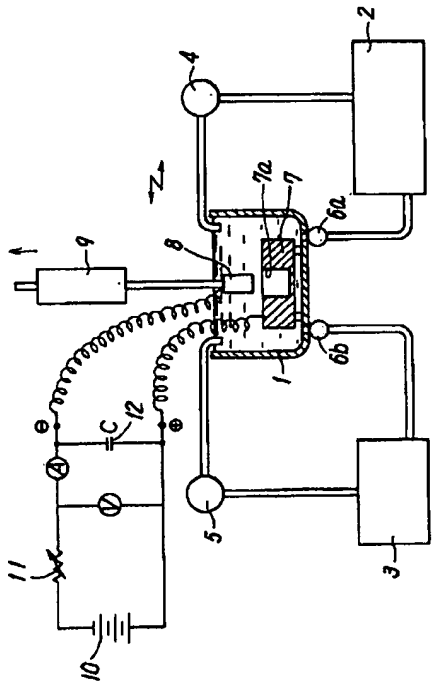
Ｆターム(参考)　3C059 AA02 AB01 CJ04 GC01 HA03

(54)【発明の名称】　放電加工面の電解仕上げ方法

(57)【要約】
【課題】 放電加工と電解研磨を同じ装置内で行なうことで、設備を小型コンパクト化し、生産コストを低減し、電解研磨時の電極工具と放電加工面との位置決めを高精度に可能とし、作業性の向上を図ることができる放電加工面の電解仕上げ方法を提供する。
【解決手段】 放電加工液が注入された容器１内に、水平面内に互いに直交するＸ，Ｙ軸方向に固定でＸ，Ｙ軸の両者に直交するＺ軸方向に移動可能な電極工具８に対して所定間隔をおいてワーク７を対向させ、ワーク７を陽極とし、電極工具８を陰極として両極間に電圧を印加し、放電によってワーク７に電極形状に応じた加工を施した後、容器１内の放電加工液を電解液に入れ替え、電極工具８とワーク７の間に一定の電解電流を流し、ワーク７の放電加工面７ａを電解によって研磨仕上げしてなる。



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【特許請求の範囲】

【請求項1】放電加工液が注入された容器内に、水平面内において互いに直交するX，Y軸方向に固定で上記X，Y軸の両者に直交するZ軸方向に移動可能な電極工具に対して、所定間隔をおいてワークを対向させ、上記ワークを陽極とし、上記電極工具を陰極として両極間に電圧を印加し、放電によって上記ワークに電極形状に応じた加工を施した後、上記容器内の放電加工液を電解液に入れ替え、上記電極工具と上記ワークの間に一定の電解電流を流し、上記ワークの放電加工面を電解によって研磨仕上げすることを特徴とする放電加工面の電解仕上げ方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、放電加工時に加工面に生じる変質層を電解により除去し研磨仕上げするための放電加工面の電解仕上げ方法に関する。

【0002】

【従来の技術】一般に、放電加工装置では、容器に注入された白灯油や水などの加工液中に、金属加工品であるワークを固定し、陽極となるワークの加工面に対して、微小な間隙を有するように陰極の電極工具を対向させ、当該間隙中で放電を行ない、ワークを放電加工するものであるが、放電加工のままでは、ワークの放電加工面に硬くて厚い変質層ができる。そこで、放電加工後、電解による仕上げ研磨工程を設け、ワークの放電加工面を電解仕上げする方法が、たとえば、「電気加工学会誌　Vol.22,No,43,P.18～28　酒井・増沢共著」に提案されている。この電解仕上げ方法は、放電加工によりワークを加工した後、ワークを陽極電極とし、ワークに対向する陰極電極を設けて、ワークの放電加工面と陰極電極とを均等な間隙を有するように静止状態に保持し、当該間隙に電圧を印加することにより、ワークの放電加工面を電解仕上げするものである。

【0003】

【発明が解決しようとする課題】しかしながら、従来例においては、放電加工と電解仕上げとが別々の装置で個別に行われており、従って、ワークの加工に際しては、放電加工装置および電解研磨装置をそれぞれ用意しなければならないため、設備が大型化し、多大の設備投資が必要になり、生産コストが高くなるという問題点がある。また、電解仕上げする際に電極工具をワークの放電加工面に位置決め設置する必要があり、このとき、電極工具と放電加工面との位置ずれが生じ、充分な位置決め精度の確保が困難であると共に、作業性が著しく低下するという問題点がある。

【0004】本発明は、上記のような問題点に鑑みてなされたものであって、その目的とするところは、放電加工と電解研磨を同じ装置内で行なうことで、設備を小型コンパクト化し、生産コストを低減し、電解研磨時の電極工具と放電加工面との位置決めを高精度に可能とし、作業性の向上を図ることができる放電加工面の電解仕上げ方法を提供することにある。本発明の上記ならびにその他の目的と新規な特徴は、本明細書の記述および添付図面から明らかになるであろう。

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【0005】

【課題を解決するための手段】上記目的を達成すべく、本発明に係る放電加工面の電解仕上げ方法は、放電加工液が注入された容器内に、水平面内において互いに直交するX，Y軸方向に固定で上記X，Y軸の両者に直交するZ軸方向に移動可能な電極工具に対して、所定間隔をおいてワークを対向させ、上記ワークを陽極とし、上記電極工具を陰極として両極間に電圧を印加し、放電によって上記ワークに電極形状に応じた加工を施した後、上記容器内の放電加工液を電解液に入れ替え、上記電極工具と上記ワークの間に一定の電解電流を流し、上記ワークの放電加工面を電解によって研磨仕上げすることを特徴としている。

【0006】従って、本発明では、放電加工が行われた容器内の放電加工液を電解液に入れ替え、Z軸方向にのみ移動可能な電極工具とワークの放電加工面との間に一定の電解電流を流し、ワークの放電加工面が電解によって研磨仕上げされるので、ワークの放電加工と電解研磨とが1つの装置内で行われる。また、電極工具とワークの放電加工面との位置関係がそのまま電解研磨に流用されるので、電極工具とワークの放電加工面との位置決めが簡便かつ確実になり、電極工具と放電加工面との充分な位置決め精度が確保され、作業性が向上する。

【0007】

【発明の実施の形態】以下、本発明の一実施の形態を図1および図2に基づいて詳細に説明する。実施の形態を説明するに当たって、同一機能を奏するものは同じ符号を付して説明する。図1は、放電加工面の電解仕上げ方法に使用する装置例を示すもので、この装置において、容器1の開口部には、水や白灯油などの放電加工液が貯留された加工液貯留タンク2、硝酸ソーダなどの電解液が貯留された電解液貯留タンク3が、ポンプ4，5を個別に介して連通されており、容器1の底部には、切換弁6a，6bをそれぞれ介して加工液貯留タンク2および電解液貯留タンク3が個別に連通され、放電加工液および電解液が容器1に供給されると共に、加工液貯留タンク2および電解液貯留タンク3に回収されるようになっている。

【0008】また、容器1内には、金属加工品であるワーク7が固定され、このワーク7の上方には、電極工具8が送り機構9によって上下方向にのみ（X，Y軸方向に固定でZ軸方向に移動可能）移動可能に設置されている。ワーク7は直流電源10の陽極に接続され、電極工具8は直流電源10の陰極に可変抵抗器11を介して接続され、ワーク7と電極工具8との間には、コンデンサ

１２が接続されている。なお、図示はしていないが、放電加工および電解研磨は、それぞれ別々の電源を用いるものとする。

【０００９】本実施の形態の放電加工面の電解仕上げ方法は、図１に示す装置を用いて、まず、切換弁６ａ，６ｂの流路を閉じた状態で、ワーク７を固定した容器１内に、ポンプ４によって加工液貯留タンク２内の放電加工液を注入した後、電極工具８をワーク７の被加工部に対して所定間隔をおいて対向させる。次に、ワーク７を陽極とし、電極工具８を陰極として、両極間に電圧を印加し、電極工具８を上下に繰り返し移動させながら、放電によってワーク７の被加工部を溶融・蒸発させることで、電極工具８の形状に応じた放電加工面７ａが形成される。この場合、電極工具８を数段階に分けて適宜形状のものと交換し、放電加工することで、所望形状の放電加工面７ａが得られる。

【００１０】その後、電極工具８を引き上げ、放電加工面７ａより離した状態で、切換弁６ａの流路を開き、容器１内の放電加工液を加工液貯留タンク２に回収する。そして、切換弁６ａの流路を閉じた状態で、電解液貯留タンク３内の電解液をポンプ５によって容器１内に注入する。

【００１１】次に、放電加工において最終的に使用した電極工具８を下降し、放電加工時と同じ微小間隙をおいて放電加工面７ａに対向させ、電極工具８とワーク７の両極間に電圧を印加すると、両極間の抵抗に逆比例した一定の電流が流れ、放電加工面７ａに生じた変質層が電解によって電解液中に溶出し、放電加工面７ａは仕上げ研磨される。

【００１２】ところで、図２は、上記の電解仕上げ方法において、パルス波を与えながら放電加工面７ａを溶出させるパルス電解を採用した場合の、電流オン・オフタイム別の加工時間に対する電極間の最終電流値の変化を示す特性図であるが、電流オンタイムが長いもの程、加工時間に伴って電流値が低下していくのが分かる。これは、電流オンタイムが長くなれば、放電加工面７ａの付近に金属イオンが電解液中に溶出し拡散した陽極液層が高濃度に存在し、電解によって生じたガスが電極工具８の表面に多く付着し、これら陽極液層やガスが電気の流れを妨げているからである。

【００１３】そこで、本実施の形態では、電極工具８を上下動させ、放電加工面７ａに対する接近・離反動作を繰り返し行なうことで、放電加工面７ａと電極工具８間の電解液の流動性をよくして、陽極液層を両極間より外部に流動させるようにすると共に、電極工具８を引き上げることで、ガス抜きを行なうようにし、電解溶出の安定化を図るようにしている。しかしながら、他の手段によって電解液の流動性を高めることもできる。

【００１４】こうして、電解研磨が終了したら、水洗を実施し、ワーク７に付着した電解液および残留物を除去する。そして、必要があれば、比較的低温の熱処理によって不安定な相を析出させ、硬度および強度を高めることもできる。

【００１５】上記電解研磨において、ワーク７と電極工具８との間隙は、主として放電加工の条件により決まり、即ち、電極工具８を放電加工時と同じ位置に戻して電解研磨するため、最終の放電加工における電極工具８と放電加工面７ａとの間のギャップによって決まり、通常は、０．２～０．３ｍｍになる。なお、場合によっては、放電加工条件により０．１ｍｍ程度になることもあり、電解研磨のために印加される電圧は、ワーク７と電極工具８との間隙の大きさに応じて適切に調整することが必要になる。ワーク７としては、Ｆｅ系、Ａｌ系、Ｃｕ系、Ｎｉ系、Ｔｉ系の金属および合金など、電解研磨可能なものなら特に限定されない。

【００１６】このように、本実施の形態の放電加工面の電解仕上げ方法では、放電加工と電解研磨とを液交換を行なうだけで、同じ容器１内で行なえるので、設備が小型化し、コスト低減が図られ、しかも電解研磨時の電極工具８と放電加工面７ａとの位置決め精度が確保され、作業性を向上することができる。

【００１７】以上、本発明の実施の形態の放電加工面の電解仕上げ方法について詳述したが、本発明は、上記実施の形態記載の放電加工面の電解仕上げ方法に限定されるものではなく、本発明の特許請求の範囲に記載されている発明の精神を逸脱しない範囲で、設計において種々の変更ができるものである。

【００１８】

【発明の効果】以上の説明から理解されるように、本発明の放電加工面の電解仕上げ方法によれば、放電加工が行われた容器内で、放電加工液を電解液に入れ替え、電極工具とワークの放電加工面との位置関係を保持した状態で、放電加工面が電解研磨され、ワークの放電加工と電解研磨とが同じ装置内で行われるので、設備を小型コンパクト化することができ、生産コストの低減化を図ることができ、電解研磨時の電極工具と放電加工面との位置決めを簡便かつ高精度に行なうことができると共に、変質層および亀裂を容易かつむらなく均一に除去することができ、作業性を向上することができる。

【図面の簡単な説明】

【図１】本発明の一実施の形態に係る放電加工面の電解仕上げ方法に使用する装置の概略構成図である。

【図２】本発明の一実施の形態に係る放電加工面の電解仕上げ方法において、電流オン・オフタイム別の加工時間に対する電極間の最終電流値の変化を示す特性図である。

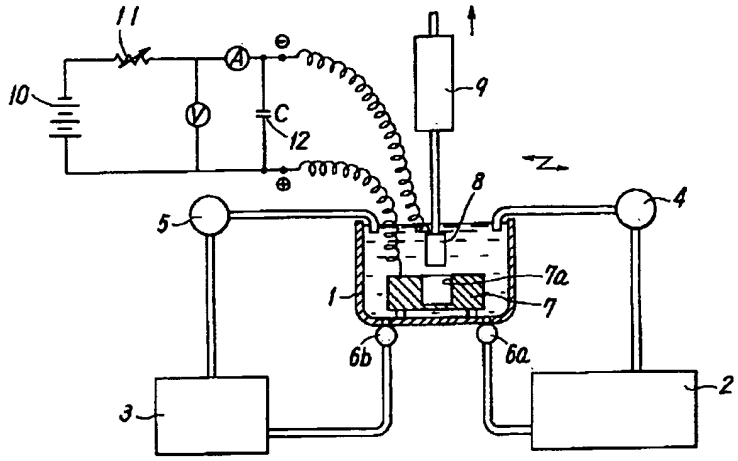
【符号の説明】

１　容器
２　加工液貯留タンク
３　電解液貯留タンク

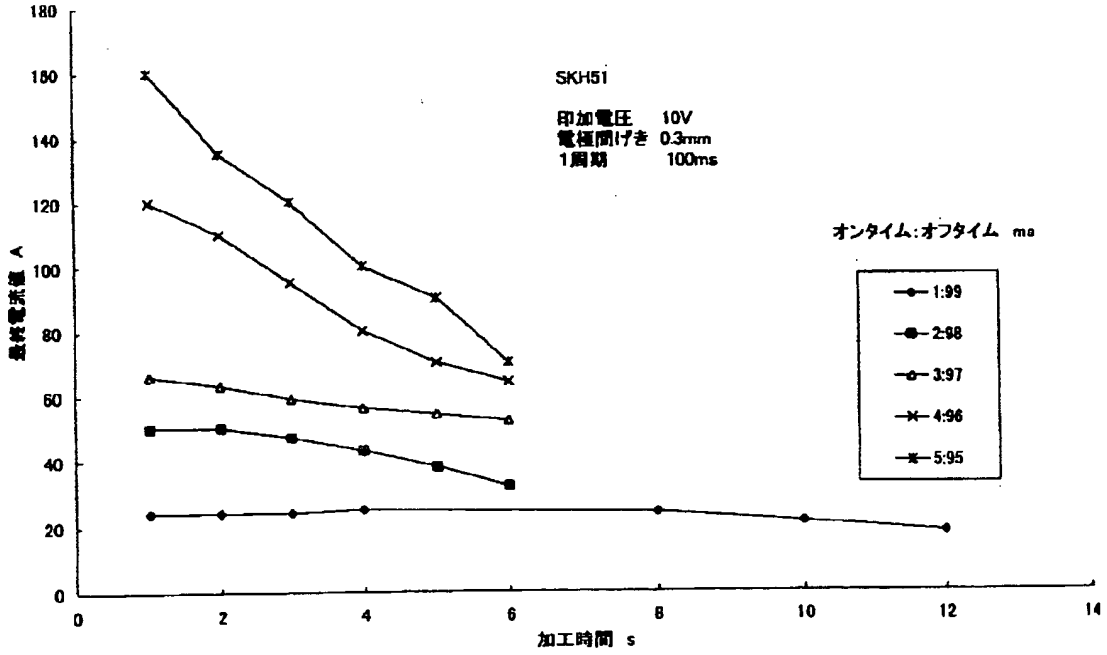
5　　6

4，5　ポンプ
6a，6b　切換弁
7　ワーク
7a　放電加工面
8　電極工具
9　送り機構
10　直流電源
11　可変抵抗器
12　コンデンサ

【図1】



【図2】



CLAIMS

[Claim(s)]
[Claim 1] As opposed to the electrode tool which can move in X which intersects perpendicularly mutually in the level surface in the container with which electrical discharge machining liquid was poured in, and the direction of the Z-axis which intersects perpendicularly with both above X and Y-axis by fixation in the direction of the Y-axis Set a predetermined interval, make a work counter, make the above-mentioned work into an anode, and voltage is impressed among two poles by making the above-mentioned electrode tool into the negative pole. The electrolysis finish method of the electrical discharge machining side characterized by changing the electrical discharge machining liquid in the above-mentioned container to an electrolysis solution, sending fixed electrolytic current between the above-mentioned electrode tool and the above-mentioned work, and carrying out polish finish of the electrical discharge machining side of the above-mentioned work by electrolysis after giving processing to the above-mentioned work according to electrode form by electric discharge.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the electrolysis finish method of the electrical discharge machining side for electrolysis removing the deterioration layer produced in a processing side at the time of electrical discharge machining, and carrying out polish finish.
[0002]
[Description of the Prior Art] As opposed to the processing side of the work which generally fixes the work which is the Metal Processing Division article in working fluid, such as illuminating kerosine poured into the container, and water, with electrical discharge machining equipment, and serves as an anode Although the electrode tool of the negative pole is made to counter so that it may have a minute gap, it discharges all over the gap concerned and the electrical discharge machining of the work is carried out, with electrical discharge machining, a hard and thick deterioration layer is made in the electrical discharge machining side of a work. Then, the method of establishing the finish polish process by electrolysis after electrical discharge machining, and carrying out electrolysis finish of the electrical discharge machining side of a work is "electricity processing

academic journal, for example. It is proposed by Vol.22, No, 43, and 28 Sakai and P.18 - Masuzawa collaboration." This electrolysis finish method uses a work as an anode electrode, after processing a work by electrical discharge machining. Electrolysis finish of the electrical discharge machining side of a work is carried out by preparing the negative pole electrode which counters a work, holding the electrical discharge machining side and negative pole electrode of a work to a state of rest so that it may have an equal gap, and impressing voltage to the gap concerned.

[0003]

[Problem to be solved by the invention] However, in the conventional example, electrical discharge machining and electrolysis finish are individually performed by separate equipment, therefore processing of a work is faced. In order to have to prepare electrical discharge machining equipment and electrolytic polishing equipment, respectively, equipment is enlarged, great plant-and-equipment investment is needed, and there is a problem that a production cost becomes high. Moreover, when carrying out electrolysis finish, it is necessary to carry out positioning installation of the electrode tool in the electrical discharge machining side of a work, the position gap with an electrode tool and an electrical discharge machining side arises at this time, and while reservation of sufficient positioning accuracy is difficult, there is a problem that workability falls remarkably.

[0004] [the place which this invention is made in view of the above problems, and is made into the purpose] It is in offering the electrolysis finish method of an electrical discharge machining side that the small miniaturization of the equipment is carried out, a production cost can be reduced, positioning with the electrode tool at the time of electrolytic polishing and an electrical discharge machining side is enabled with high precision, and improvement in workability can be aimed at by performing electrical discharge machining and electrolytic polishing within the same equipment. The above of this invention, and the other purposes and the new feature will become clear from description and the accompanying drawing of this Description.

[0005]

[Means for solving problem] [that the above-mentioned purpose should be attained / the electrolysis finish method of the electrical discharge machining side concerning this invention] As opposed to the electrode tool which can move in X which intersects perpendicularly mutually in the level surface in the container with which electrical discharge machining liquid was poured in, and the direction of the Z-axis which intersects perpendicularly with both above X and Y-axis by fixation in the direction of the Y-axis Set a predetermined interval, make a work counter, make the above-mentioned work into an anode, and voltage is impressed among two poles by making the above-mentioned electrode tool into the negative pole. After giving processing to the above-mentioned work according to electrode form by electric discharge, the electrical discharge machining liquid in the above-mentioned container is changed to an electrolysis solution, fixed electrolytic current is sent between the above-mentioned electrode tool and the above-mentioned work, and it is characterized by carrying out polish finish of the electrical discharge machining side of the above-mentioned work by electrolysis.

[0006] Therefore, in this invention, the electrical discharge machining liquid in the container with which electrical discharge machining was performed is changed to an electrolysis solution. Since fixed electrolytic current is sent between an electrode tool and the electrical discharge machining side of a work movable only in the direction of the Z-axis and polish finish of the electrical discharge machining side of a work is carried out by electrolysis between, the electrical discharge machining and electrolytic polishing of a work are performed within one piece of equipment. Moreover, since the physical relationship of an electrode tool and the electrical

discharge machining side of a work is diverted to electrolytic polishing as it is, positioning with an electrode tool and the electrical discharge machining side of a work becomes simple and certain, sufficient positioning accuracy of an electrode tool and an electrical discharge machining side is secured, and workability improves.
[0007]
[Mode for carrying out the invention] The form of 1 operation of this invention is hereafter explained in detail based on drawing 1 and drawing 2 . In explaining the form of operation, what does the same function so attaches and explains the same mark. Drawing 1 shows the example of equipment used for the electrolysis finish method of an electrical discharge machining side, and in this equipment [the opening of a container 1] [the electrolysis solution storage tank 3 by which electrolysis solutions with which electrical discharge machining liquid, such as water and illuminating kerosine, was stored, such as the working fluid storage tank 2 and sodium nitrate, were stored] It is open for free passage individually through a pump 4 and 5, and [the bottom of a container 1] It is collected by the working fluid storage tank 2 and the electrolysis solution storage tank 3, while the working fluid storage tank 2 and the electrolysis solution storage tank 3 are individually opened for free passage respectively through a change-over valve 6a and 6b and electrical discharge machining liquid and an electrolysis solution are supplied to a container 1.
[0008] Moreover, in the container 1, the work 7 which is the Metal Processing Division article is fixed, and the electrode tool 8 sends above this work 7, and it is installed by the mechanism 9 possible [movement (movement in the direction of the Z-axis is possible in X and the direction of the Y-axis at fixation) only in the up-and-down direction]. A work 7 is connected to the anode of the direct-current power supply 10, the electrode tool 8 is connected to the negative pole of the direct-current power supply 10 through the variable resister 11, and the capacitor 12 is connected between the work 7 and the electrode tool 8. In addition, although illustration has not been carried out, a respectively separate power supply shall be used for electrical discharge machining and electrolytic polishing.
[0009] [the electrolysis finish method of the electrical discharge machining side of the form this operation] After pouring in the electrical discharge machining liquid in the working fluid storage tank 2 with a pump 4, the electrode tool 8 is made for a predetermined interval to set and counter to the part of a work 7 to be processed in the container 1 which fixed the work 7, where a change-over valve 6a and the channel of 6b are first closed using the equipment shown in drawing 1 . Next, a work 7 is made into an anode, voltage is impressed among two poles by making the electrode tool 8 into the negative pole, and the electrical discharge machining side 7a according to the form of the electrode tool 8 is formed by melting and making it evaporate in the part of a work 7 to be processed of electric discharge, repeating the electrode tool 8 up and down, and moving it. In this case, the electrode tool 8 is divided into several steps, it exchanges for the thing of form suitably, and the request-shaped electrical discharge machining side 7a is acquired by carrying out electrical discharge machining.
[0010] Then, the electrode tool 8 is pulled up, in the state where it detached from the electrical discharge machining side 7a, the channel of a change-over valve 6a is opened, and the electrical discharge machining liquid in a container 1 is collected on the working fluid storage tank 2. And where the channel of a change-over valve 6a is closed, the electrolysis solution in the electrolysis solution storage tank 3 is poured in into a container 1 with a pump 5.
[0011] Next, if descend the electrode tool 8 finally used in electrical discharge machining, and set the same minute gap as the time of electrical discharge machining, the electrical discharge machining side 7a is made to counter and voltage is impressed among the two poles of the electrode tool 8 and a work 7 The fixed current

inversely proportional to resistance between two poles flows, the deterioration layer produced in the electrical discharge machining side 7a is eluted in an electrolysis solution by electrolysis, and the electrical discharge machining side 7a is finished and ground.

[0012] By the way, [drawing 2] although drawing 2 is the characteristic figure showing the change of the inter-electrode last current value to the floor to floor time according to current on-off time at the time of adopting the pulse electrolysis which makes the electrical discharge machining side 7a eluted in the above-mentioned electrolysis finish method, giving a pulse wave The thing which has long current ONTAIMU is understood that a current value falls in connection with floor to floor time. This is because the anode solution layer which the metal ion eluted for which and diffused in the electrolysis solution near the electrical discharge machining side 7a existed in high concentration, a lot of gas on the surface of the electrode tool 8 produced by electrolysis adhered and these anodes solution layer and gas have barred the electric flow, if current ONTAIMU becomes long.

[0013] [then, the thing which the electrode tool 8 is moved up and down and performed by repeating approach / estrangement operation to the electrical discharge machining side 7a with the form of this operation] While receiving the mobility of the electrolysis solution between the electrical discharge machining side 7a and the electrode tool 8 and making it make an anode solution layer flow outside from between two poles, he is made to perform gas omission and is trying to attain stabilization of electrolysis elution by pulling up the electrode tool 8. However, other means can also raise the mobility of an electrolysis solution.

[0014] In this way, if electrolytic polishing is completed, it will wash and the electrolysis solution and residue adhering to a work 7 will be removed. And if there is necessity, comparatively, by low-temperature heat treatment, unstable ** can be deposited and hardness and intensity can also be raised.

[0015] In the above-mentioned electrolytic polishing, [the gap of a work 7 and the electrode tool 8] It is decided mainly by the conditions of electrical discharge machining, namely, in order to return the electrode tool 8 to the same position as the time of electrical discharge machining and to carry out electrolytic polishing, it is decided by the gap between the electrode tool 8 and the electrical discharge machining side 7a in the last electrical discharge machining, and it is usually set to 0.2-0.3mm. In addition, it is necessary to adjust appropriately the voltage impressed for electrolytic polishing according to the size of the gap of a work 7 and the electrode tool 8, since it is set to about 0.1mm according to electrical discharge machining conditions depending on the case. As a work 7, especially if electrolytic polishing is possible for metal, an alloy, etc. of Fe system, aluminum system, Cu system, nickel system, and a Ti system, it is not limited.

[0016] thus, [the electrolysis finish method of the electrical discharge machining side of the form this operation] Since electrical discharge machining and electrolytic polishing can be performed within the same container 1 only by performing liquid exchange, equipment is miniaturized, cost reduction is achieved, moreover the positioning accuracy of the electrode tool 8 at the time of electrolytic polishing and the electrical discharge machining side 7a is secured, and workability can be improved.

[0017] As mentioned above, although the electrolysis finish method of the electrical discharge machining side of the form operation of this invention was explained in full detail This invention is not limited to the electrolysis finish method of the electrical discharge machining side the above-mentioned implementation given in a form, is the range which does not deviate from the soul of invention indicated to the Claims of this invention, and can perform various change in a design.

[0018]

[Effect of the Invention] [according to the electrolysis finish method of the electrical discharge machining side of this invention] within the container with which electrical discharge machining was performed so that I may be understood from the above explanation Where it changed electrical discharge machining liquid to the electrolysis solution and the physical relationship of an electrode tool and the electrical discharge machining side of a work is held Since electrolytic polishing of the electrical discharge machining side is carried out and the electrical discharge machining and electrolytic polishing of a work are performed within the same equipment While being able to carry out the small miniaturization of the equipment, being able to attain reduction-ization of a production cost and being able to perform positioning with the electrode tool at the time of electrolytic polishing, and an electrical discharge machining side simple and with high precision A deterioration layer and a crack can be removed easily and uniformly uniformly, and workability can be improved.

[Translation done.]

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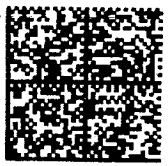

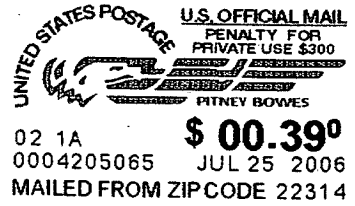

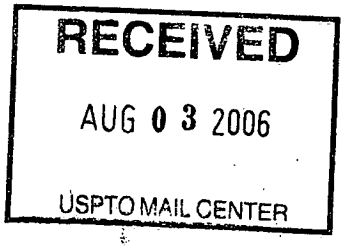

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